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THE EVOLUTIONS OF ORGANIZATION.

ADDRESS
TO THE
MEDICAL STUDENTS

AT THE OPENING OF THE WINTER SESSION,
UNIVERSITY OF GLASGOW,

TUESDAY, OCTOBER 26, 1880.

BY

JOHN CLELAND, M.D., F.R.S.,
PROFESSOR OF ANATOMY, UNIVERSITY OF GLASGOW.

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THE EVOLUTIONS OF ORGANIZATION.

THE study of medicine presents to him who would view it properly two great aspects:—primarily, it exhibits an art for the relief of the sufferings of others; but it also displays a wide field of investigation for the satisfaction and development of the inquirer's own mind. So evidently is this the case, and so naturally does the study of the body tend to a wider survey of the realms of nature, that in ancient, as well as more modern times, research of the most extensive character, and far-reaching speculations, have occupied the attention of physicians. As soon as the student begins his curriculum, by seeking a knowledge of the human body he comes into the presence of the great system of organization on the face of the earth, of which the structure of man forms the crowning object, not to be justly appreciated save in conjunction with the rest. As he becomes acquainted with the phenomena of life, and learns the mechanical and chemical processes involved in them, he naturally asks how far the laws of life are to be explained by the laws of matter, and what is the motive power of the order of phenomena both in the individual and in the series. There come up for his consideration the links uniting to the body that spiritual element which, in the actions of the individual, is never seen by us in operation, save in the closest association with physical structure. And the yet larger speculation, Is spirit or matter the prior, the underlying, unchangeable, and eternal element, constantly obtrudes itself on the horizon of more limited inquiries.

These are all questions which have been much discussed in recent times; and the order of the appearance of structures having been studied both in the form of palæontology and development, it is not wonderful that speculations have been rife as regards not only the nature, but likewise the origin of life, of species, of matter, and intelligence.

That there is a certain unity binding together the most diverse forms of organization is a doctrine which, at this date, I fancy no one will deny. The similarity of the units of life in plant and animal texture, and the general, if not altogether universal, pervasion of sexual distinction, are illustrations of that; and if I confine my view to the animal kingdom, I think the days are past when any one will consider it chimerical to compare vertebrates with invertebrates, or the most dissimilar invertebrates one with another. At once it will be granted that ova, however various, are comparable, and that it is matter for observation to compare the stages of their growth as they give rise to forms that are far asunder. Nor will any serious doubt be entertained on survey of that highest and most important assemblage of animals the vertebrata, that they have appeared on earth in the order of their complexity; however great may be the mystery in which the rise of invertebrata may be wrapped. All this involves the conception of a complex unity acquiring its complexity stage by stage, even as the individual develops from the ovum to the adult condition; and such a conception may be justly termed Evolution.

But such an evolution may be conceived of variously, both in respect of character and cause. In its character it may be conceived of as a growth without aim, forming altogether an indefinite aggregation like the sum of the branches of a tree; or the view may be held that it is an orderly arrangement, like some vast temple in which every minaret and most fantastic ornament has got its own appointed place and harmonies, while the central tower ascends to its pre-ordained completion,—an evolution like that of a plant from whose root-leaves the shoot ascends with leaves that change their character according to law, till the summit is reached, where definite groups converge, assorted to complete the flower.

And just as there are diverse notions as to the character of the evolutions of life on the globe, so there is difference of opinion as to the source from which it springs. There are some who still deny the genetic connection of different forms of life, and others who either consider genetic connection proved, or look on it as a hypothesis with more or less probability in its favour; and among these latter there are some who see no morphological facts which cannot be explained by reference to genetic relationship and its involved lines of heredity; while there are others like myself who, in heredity, can only recognise a phenomenon the origin of which demands an explanation.

It is a very remarkable circumstance that while all these views are held and have been known to the scientific world for a great length of time, the name of *Evolutionists* has, with curious obliviousness, been assumed as a distinctive title by those who believe that the evolution is merely indefinite and entirely to be explained by heredity. It is for them to say if this exactness in the choice of a name is an index of the accuracy of the reasoning on which their views are founded. Had they called themselves Demolitionists, on account of their disbelief in morphological design, the name might possibly have been more expressive.

Looking, however, at evolution in the natural sense of the word, we may find it useful to give a glance to some of the more notable opinions that have been held on the subject.

In such a survey, however brief, the school of Schelling, as represented by Oken and Carus, must not be overlooked. Professor Häckel of Jena claims for Oken a foremost place in the pedigree of that system which he has himself put forward; and, undoubtedly, though there is little other affinity between Häckelism and the doctrine which Oken published at the same University of Jena in his "Naturphilosophie" in 1810, than that both draw largely on the imagination, Oken's is a theory of evolution embracing all Nature. It is built upon an *a priori* conception. It constantly declares that things must be after a certain fashion, simply because the conception demands it; and it is scarcely surprising that, proceeding by this method, not distinguishing between speculation and demonstration, its details are often far astray. His own words are:—" I am very well aware that there is many an object which does not stand in its right place, but where again is there a single system in which this is not more strikingly the case? We have here dealt only with the restoration of the edifice, wherein, after years of long and oft-repeated attempts, the furniture may for the first time be properly distributed, without detriment to its general bearings or ground plan."[1]

That which made Oken's writings a living power was, that to him nature was in all its parts replete with meaning, inspired with an inherent fitness, and not the mere chance result of a concourse of atoms unaccounted for. Laying the foundation of his system in a mathematical conception, he seeks to ally himself not to Epicurus but to Pythagoras. " Every real," he says, "is absolutely nothing else than a number. This must be the sense entertained of numbers in the Pythagorean doctrine, namely, that everything or the whole universe had arisen from numbers. . . . The essence in numbers is naught else than the Eternal. The Eternal only is or exists, and nothing else is when a number exists."[2] He lays claim to having advanced, so

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[1] Elements of Physiophilosophy, translated for the Ray Society by Alfred Tulk, p. xiv.

[2] Op. cit. p. 13.

early as 1805, the doctrine that all organic beings originate in and consist of cells, which constitute the protoplasm from which all larger organisms are evolved;[1] and he is more generally recognised as having been the first to perceive that the skull consists of segments in serial continuity with those of the vertebral column. But principally it concerns us to notice that while Oken appreciated the correspondence between the ovum, the beginning of life in the complex animal, and the "oozoa" or simplest forms of animals, he saw in the animal world an unity completed in man; or, to use his own words, the animal kingdom is only a dismemberment of the highest animal, *i.e.*, of *man.*"[2]

The plan sketched by Oken was, so far as the animal kingdom was concerned, modified and elaborated by C. G. Carus. Guided, like Oken, by the aphorism that the whole is repeated in every part, Carus published with his beautiful work on Comparative Anatomy a volume of "Researches on Philosophic or Transcendental Anatomy," as perplexing a puzzle as could well be conceived for a plain observer of Nature. But it is to be noted among the much that is good which we owe to him, that he recognised as a cardinal fact the central

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[1] Op. cit. p. xi.

[2] Op. cit. p. 494.

position of the digestive system throughout the animal kingdom, the truth at the bottom of Häckel's gastræa theory; and that he so far appreciated the relation of the segmented invertebrata to the vertebrata as to perceive that, while in certain lower forms the nervous system completed a circle round the mouth, in the invertebrate segmentata the nervous centres were concentrated on the under, and in the vertebrata on the upper side; seeing in this what Oken had already observed through the organic world, and what so skilled and accurate an observer as Dana[1] has more recently recognised in this very matter, a system of expression in nature, according to which things of highest dignity are placed uppermost.

In France, Etienne Geoffroy St. Hilaire, claiming to be free from all *a priori* fancies, but acknowledging the influence which the definition of Leibnitz had on him, that "the order of the universe is variety in unity," was led to the conception of the "unity of organization" by the results of researches into points of detail; and collecting those detailed researches in one work, his "Philosophie Anatomique," he commences by asking, "Can the organization of vertebrate animals be reduced to one type?"[1] and subsequently arrives at the doctrine that "all animals are made on one and the same type." Founding on observation, this great anatomist appreciated not only the correspondence of part with part in different animals, but the existence of inherent laws of symmetry and order governing the formation of structures similar in different animals and hereditarily transmitted. To express it in the distinct nomenclature of Owen, he recognised the existence of general as well as special homologies. The compeer of Lamarck, he saw reason, even before that writer, to judge that the dogma of immutability of species, in all time and circumstances, lacked proof; and, at a period later than Lamarck's work, he cast it aside, thus affording evidence to those who may require it that the appreciation of the orderly internal laws of organization is not inconsistent with a full appreciation of the possibility of a genetic connection of diverse forms — seeing that, in this instance, one independent thinker originated for himself both ideas, and clearly perceived that the second could in no degree allow the first to be dispensed with. His notion was, that the "ambient world having undergone changes from one geological epoch to another, even the atmosphere having varied in chemical composition, and the conditions of respiration having been thus modified, actual forms had to differ in organization from their ancestors of ancient times, and that according to the degree of the modifying force."[1]

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[1] J. D. Dana "On Cephalization," &c. Ann. and Mag. Nat. Hist., Sept., 1863.

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[1] Philosophie Anatomique, II., p. 445.

Lamarck, who next claims attention, has given the summary of his doctrine in language so brief and clear, that I may quote his own words. He lays down four principles :—" 1. Life, by its own forces, tends continually to increase the volume of the whole body which possesses it, and to extend the dimensions of its parts up to a limit which it determines. 2. The production of a new organ in an animal body results from a new want supervening, which continues to make itself felt, and from a new movement which this want gives birth to, and continues. 3. The development of the organs and their force of action are constantly in ratio of the employment of these organs. 4. All that has been acquired, laid down or changed, in the organization of the individuals during the course of their life, is conserved by their generation and transmitted to the new individuals proceeding from those which have undergone those changes."[2]

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[1] Mémoires de l'Academie Royale des Sciences, XII., 63. Isidore Geoffroy St. Hilaire, Histoire Naturelle Générale, II., p. 416.

[2] Lamarck, Hist. Nat. des Animaux sans Vertèbres. 3rd Edition, p. 57.

The proofs of the effect of new wants or appetency, in producing new organs, he derives from the acknowledged effect of habitual action in increasing the development of organs. But while it is difficult to limit the results of use, disuse, or peculiar action in developing, dwindling, or modifying structures already in some form existing, it is not easy to understand how such a principle could operate to produce an organ the basis of which was not previously laid down.

That which gives the air of absurdity to Lamarck's illustrations is that, altogether unlike St. Hilaire, he appears to have ignored the necessity for a principle independent of external circumstances to regulate form, in, for example, such matters as symmetry. The following may be given as an instance: — "I conceive that a gasteropod mollusc, which, as it crawls along, finds the need of touching the bodies in front of it, makes efforts to touch those bodies with some of the foremost parts of its head, and sends to these every time quantities of nervous fluids, as well as other liquids. I conceive, I say, that it must result from this reiterated afflux towards the points in question that the nerves which abut at these points will, by slow degrees, be extended. Now, as in the same circumstances other fluids of the animal flow also to the same places, and especially nourishing fluids, it must follow that two or more tentacles will appear and develop insensibly in those circumstances on the points referred to. This is, without doubt, what has happened in all the races of gasteropods whose wants have given rise to the habit of touching bodies with the parts of their head."[1] Thus he allowed himself to pass in the most guileless way, like many a subsequent writer, from "*je conçois*" to "*sans doute.*"

Lamarck espoused the doctrine of spontaneous generation, as he was bound logically from his point of view to do. His contention was that it was improbable that under the government of the material universe by secondary causes there should be a deviation from that system either in the first appearance or subsequent evolution of life; and he failed, erroneously, as I believe, to see that in the phenomena of life any element was present different in kind from the phenomena of dead matter. "Certes," he says, "the power which has made the animals has made them all that they are, and endowed them with the faculties observed in each, by giving an organization fitted to produce them. Observation authorises us to recognise that this power is *Nature*, and that she is the product of the will of the Supreme Being, who has made her what she is."[1] Observe how unjustifiable are the charges which have been brought against him from a theological point of view. "Chose étrange!" he exclaims afterwards, "l'on a confondu la montre avec l'horloger, l'ouvrage avec son auteur."[2]

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[1] Op. cit. p. 59.

In 1844 there was published in Edinburgh the book entitled "Vestiges of the Natural History of Creation," a work which appears to have been treated with scant justice by any party. Darwinians have thought it necessary to disparage both this work and Lamarck; while to those defenders of Christianity who have so little faith in its own strength that they think it cannot stand without their coopering, and smell danger perpetually from afar, it mattered nothing that the author of the "Vestiges," as well as Lamarck, emphatically declared the necessity, according to his view, for a Creator. He described himself modestly as "a private person with limited opportunities of study"; and in the wide area over which he ranges he sometimes seeks support from things which an expert in this or that department would touch with a wary hand; but independence and originality, temperance and frankness are qualities which he displays in an unusual degree.

The reasons which led him to think that spontaneous generation had, at least at a former period of the earth's history, existed, were the same as influenced Lamarck; but his hypothesis of the mode in which variety and complexity have been reached is different, namely, "that the several series of animated beings, from the simplest and oldest, up to the highest and most recent, are, under the providence of God, the results, *first*, of an impulse which has been imparted to the forms of life, advancing them in definite times, by generation through grades of organization terminating in the highest dicotyledons and vertebrata, these grades being few in number, and generally marked by intervals of organic character, which we find to be a practical difficulty in ascertaining affinities; *second*, of another impulse connected with the vital forces, tending in the course of generations to modify organic structures in accordance with external circumstances, as food, the nature of the habitat and the meteoric agencies, these being the 'adaptations' of the natural theologian."[1] Thus, while he saw the possibility of a modifying power being exerted by external circumstances, he appreciated clearly the necessity of recognising an element on which it was exerted; and the necessity for that 'impulse,' as he calls it, ought to have warned him from adhesion to spontaneous generaation. But I hold him to be right in considering the progress from simpler to more complex life in the history of the earth as being analogous to the development of an individual from the embryonic to the adult condition, a definite, and not an indefinite evolution.

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[1] Op. cit. p. 66.

[2] Op. cit. p. 95.

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[1] Vestiges of the Nat. Hist. of Creation, 10th edition, p. 155.

Such were the various views involving an evolution in one sense or another with which biology was familiar before the year 1859, when Darwin's Origin of Species made its appearance. In that work there is full agreement with Lamarck in respect that the origin of life from a creator is frankly and continually referred to, and that the question brought up is essentially the old one of the degree in which forms through long epochs of time are capable of changing; but spontaneous generation is let alone, and the author is content to express his belief that "animals have descended from at most only four or five progenitors, and plants from an equal or lesser number."[1] The new element imported into the discussion is, as you are aware, what he terms "natural selection," a result of the struggle for existence. This struggle for existence had already been pointed out by Owen[2] as a potent factor in extinction of species, but it was left for Darwin to originate the idea that it could do what Owen recognised as due to innate causes, viz., that it could produce variety and advance by the continual survival in the contest of the "fittest," *i. e.* of those which by accidental variations of structure had in the struggle an advantage over their neighbours. The struggle exists, beyond all question; and few can read Darwin's works without being impressed with the likelihood of its resulting during long periods in an indefinite amount of variety. Yet, even as to this, it may be remarked that there is a tacit assumption in the theory, that individuals surviving by slight variations of different kinds would be separated one from the other, so as not to mix the different peculiarities to which they severally owed their survival; and it may be objected that such separation would be unlikely so long as the variations were yet exceedingly slight; while it may be judged probable from Mr. Darwin's own researches that individuals with slight consanguinity and differing minutely one from the other, but not too greatly, would be exactly those which would be most prolific and so give rise to a mixing of incipiently diverging characters.

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[1] Origin of Species, 3rd edition, p. 518.

[2] Zoological Transactions, vol iv, p. 15. See, also, Comparative Anatomy of Vertebrates, vol. iii, p. 799.

The more important criticism can in no way be eluded that the doctrine of natural selection has precisely the same defect as the Lamarckian doctrine of appetency, only to a greater degree; it does not account for the formation of any new organ, nor for new organs appearing symmetrically. No doubt, on the "je conçois" principle it may be made to lengthen and strengthen to any extent any number of structures already existing, and, potent for degeneration also, may be supposed to dwarf others, when they become incumbrances. Thus it is noticeable that in the series of forms preceding the limbs of the horse, a story on which so much is sometimes founded, no new structure makes its appearance; simply the third digits have enlarged in size, while those on each side have become smaller; and in the horse of the present day both the enlargement and the dwindling have reached a degree beyond which it is difficult to conceive them passing. I notice these circumstances though I am not prepared to dogmatize to the effect that it actually was by the sole agency of natural selection that the series of limb-forms alluded to found an appropriate completion in the horse. But that natural selection should give rise to totally new and symmetrical organs is hard to imagine and impossible to prove. Mr. Darwin, to a certain extent, acknowledged the difficulty, and boldly he launched an attempt to account for the organ of vision, on the principle that if so complex a structure could be disposed of, no difficulty need be made about any other. Starting from a nerve-extremity coated with pigment as the simplest in "the great kingdom of the Articulata" he sees no difficulty "in believing that natural selection has converted the simple apparatus of an optic nerve merely coated with pigment and invested by transparent membrane into an optical instrument, as perfect as is possessed by any member of the great Articulate class."[1] Then, without attempting to explain the vertebrate eye, which, in the individual, is developed like many other structures, through a series of forms utterly incapable of function, he tells the reader that, if he finds the other facts in the book bear out the theory, he is bound to admit that the eye of an eagle might be formed by natural selection. No doubt, the evolution of the vertebrate from the invertebrate eye is made easier by Kowalevsky's discoveries in the larval ascidians; but what is called an eye in amphioxus is only a spot without mechanism for vision, so that it is really true that the invertebrate eye is blotted out before the true vertebrate eye, which, in the individual, passes through so many visually useless stages of development, suddenly appears before us, explain it as you will, in full functional operation. But even supposing, as seems possible enough, that vertebrates possessing vision were once linked to forms like larval ascidians by animals of soft structure with gradually increasing perfection of sight, and that amphioxus is after all degenerated from some member of such a lost chain of transitional forms, the visually useless stages of development of the vertebrate eye cannot be the mere accumulated record of a series of gradually improving optical instruments.

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[1] Op. cit. pp. 206 and 207.

No more than Lamarck has Darwin considered that it is not a sensitive nerve alone which is required to begin vision or any other special sense, but a capability of the consciousness to be modified in a way altogether incomparable with the equally incomprehensible affection which constitutes general sensation.

While the Darwinian system adds the idea of natural selection to the stock of hypotheses for explanation of evolution by external influences, it denies the existence of any definite evolution of organization dependent on a definite cause. While it has the greatest faith in the power of the ovum to carry down the most minutely determined details of future development, it denies that there is anything apart from the accidents of external circumstances to direct the paths of the whole world-history of life, and thus shuts out of consideration the whole class of phenomena which were not only built on by Oken, but were patent to St. Hilaire, and Owen, and Goodsir; and it not only leaves both sex and symmetry unaccounted for, but renders them inexplicable, although they are matters obvious to every one, and pervading the whole organic world.

It is worthy of notice that the position taken, with admirable moderation, by Darwin himself, that living forms have originated from a very few progenitors, is no aid to the conception of continuity, unless there be added the doctrine of spontaneous generation,—the absence of evidence for which has been the subject of an honest and pathetic wail from an eminent Darwinian. Either the assumed primordial forms sent onward, in the stream of heredity to future ova, a something not derived from external circumstances, or they owed all their properties to the operation of the laws of dead matter. If they were the accidental evolutions of dead matter,—that is spontaneous generation. If they owed their properties to another source, then every ovum that exists has similar properties distinct from those of dead matter, as believers in definite evolution or morphological design contend.

Professor Häckel, of Jena, founding on the Darwinian hypothesis, not only pushes it to the furthest limit, but accounts for every thing by what he calls the "monistic philosophy."

According to the materialists, says he, the matter has originated the force; and, according to the spiritualists, the force has originated the matter; but both are dualistic and wrong: according to the monistic philosophy you can neither think of force without matter, nor of matter without force. "Spirit and soul are only higher and combined or differentiated powers of the same function, which we indicate by the most general expression as force; and force is an universal function of all matter."[1] He has interested himself and his readers inventing most detailed pedigrees of different forms, more or less valuable, according to the degree in which they express established morphological affinities, and recommends, to the consternation of so able a scientific and political authority as Virchow, that this sort of thing should be taught in the public schools of Germany. He talks with admiration of Oken and St. Hilaire as his predecessors in evolution, and fails to see that they were on another line of rails, and moving in an opposite direction. Affinity means morphological relationship, and is a matter of observation; but the pedigree of species cannot, in the nature of things, be the subject of either observation or induction. Every affinity pointed out is a scientific gain; but it is no advantage to science to put affinities forward in the form of an allegation that the allied forms are descended from a common ancestor of imaginary structure. If evolutions are definite, or, in other words, if morphological design exist, the necessity for explaining *all* affinity by genetic relationship disappears.

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[1] Anthropogenie, pp. 707-8.

The quotation from Häckel just made will probably lead you to reflect that it is of the utmost importance, in considering the relations of both life and intelligence to matter, to have a clear understanding what the properties of matter are. Now, if we consider the phenomena of matter in its inorganic forms, we cannot fail to see that they are all of one order,—viz., related to movement in space. The energy spoken of in connection with matter is nothing but movement and tendency to movement,—a thing whose dealings are altogether with locality. But it is the immediate experience of every one that consciousness is not movement in space. No doubt it is found indirectly by science that consciousness does not exist in organisms without a proportionate amount of molecular action ; but that is no reason for confounding the one thing with the other, and saying that consciousness *is* molecular action,—a statement which conveys no meaning.

And just as consciousness is not to be confused with the molecular actions associated with it in organisms, so life is something else than the sum of the chemical and mechanical operations engaged in its manifestation. Its phenomena are no doubt mere movement in space, and therefore allied to those of matter rather than to those of consciousness, but they exhibit two closely connected characters—development and heredity, to which we find nothing analogous in the inorganic world. Crystallization is not analogous to development, for crystallization is uniform in its intimate parts; whereas the essence of development is the sequence of a definite series of forms entirely differing one from another, and heredity is the transmission of this remarkable property. While, then, the experiments of Pasteur and Lister conclusively prove that there is no such thing as spontaneous generation in the present; the difference in character between development and the laws of matter, makes spontaneous generation an inadequate hypothesis to account for the first appearance of life in the past.

Much less shall we feel inclined to such a notion, if we discern in the whole train of life on the face of the earth a series of developments in different directions, as determined as the development of the ovum into an adult individual.

But, it will be said, what of the law of continuity? It is for the sake of continuity that spontaneous generation has been sought after. If, it is argued, the evolutions of the movements, forms, and conditions of the heavenly bodies have happened by the mere laws of matter, is it likely that there has been the intervention of miracle in peopling this world of life? Well, as I read the series of evolutions, we must begin where Plato began, with the Eternal and Unlimited. Matter, the lowest grade of the evolving cosmos in which we are placed, is an exhibition of that divine energy acting from points in only one manner, namely, movement in space, and those centres of movement only exist as such one for another. In that case, matter is not eternal, but is itself an intrusion into the field which it occupies, followed in the history of this globe by other intrusions in which all the continuity existing is that they occur gradually. We do not know how gradually matter came to its present condition ; but if the whole area of space within our cognizance gives no hint of a development from which sprang the separate chemical elements so-called, what likelihood is there that the span of their changes in time could come within our recognition? The phenomena peculiar to life, and summed up in development, we know have appeared by slow degrees; and intelligence, an addition totally different in kind, both from matter and from life, makes its appearance likewise by insensible gradation.

If the development of each individual be related to a larger development as the lives of the tissue-elements are related to the life of an organism, and if that larger development proceeds in definite directions to termini or adult conditions, I own that I can see nothing out of harmony. It has seemed to some of the ablest biologists that have ever lived that there is a vast amount of evidence that such termini exist. But the prejudiced superstition that starts with the dogma that there can be no design nor aught that is complete in nature, because the laws of matter must be capable of accounting for everything, never deigns to consider the evidence of ordered evolution or completeness, but sets it aside with a sneer as "scholastic nonsense" and "archetypal follies," and calls that attitude the "method of modern science." Rather, I apprehend, the method of true science, modern or not, would be to study each evolution separately, attending to all the phenomena, and investigating its limits, and the action of every possible factor in its production. Thus, truly, it is of importance to study the operation of circumstances of environment at the present day, that we may understand the effects of environment in the past; and science is enormously indebted to Darwin for the stimulus which he has given to that inquiry. But just as in the evolution of language, although environment plays an all-important part, the fundamental factors are the existence of ideas to communicate and a parallelism of things of of different order, rendering it possible for ideas to be represented by signs, so also in the evolutions of organization there is a non-material element in the definitely directed impulse, and there is a physiognomic propriety in organic forms, a class of facts appreciated by both Oken and Dana, telling of spirit which pervades the whole.

It is certain that the evolutions of form after passing through periods of activity do cease; for while all the most curious forms of invertebrate life,—polyzoa, echinodermata, lamellibranchs, brachiopoda and cephalopoda, are formed already in palæozoic times, the vertebrates have in the same circumstances of geological change been most active since then, and passed from piscine forms on to man. And neither the structure nor the intellect of man surpasses now the perfection that it had reached in ancient Egypt and in Greece; though the lapse of time has proved sufficient for variations and degenerations. The definite lines of development on which the head had gradually risen to the perfection exhibited by the classic sculptors are incapable of being carried further: the face is carried back under the skull so far that it could not be carried back to a greater extent, and leave room for teeth, tongue, and throat.

Nor can attention be too frequently directed to the ordered and completed evolution seen in the history of the heart, a remarkable series from the simple to the complex, but showing in the amphibian and reptilian stage a more complex mechanism, yet less perfect machine than in the fishes, so that, as I have elsewhere said, "it might have been difficult to explain if it could have been noted by an observer before birds and mammals appeared on the earth."[1] But the mechanism gradually developed is completed, with variety, in the bird and mammal, and shows no sign of undergoing further complication.

One often hears final causes spoken of with a contempt which is indeed only a revulsion from a style of writing which will not now find many admirers, in which adaptations were found by pointing out what extraordinary consequences would follow some impossible alteration in nature, and final were made to do the duty of efficient causes; but in the history of the vertebrate heart may be seen a remarkable instance of the definite evolution of a complex mechanism to perform a particular kind of work. There is no reason to doubt that here we have morphological evolution, and final cause combined; just as it is possible to imagine, though we may have little experience of it, a building morphologically belonging to the Gothic order, yet teleologically fitted for the wants of modern science.

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[1] Animal Physiology, p. 116.

It is a legitimate position to take up, that all the evolutions of nature are definite, but that the series of such evolutions is indefinite in number and kind; that individual evolutions, like other individuals, are finite, but form members of a larger total. So, in the evolutions of organization we see vortic units, the textural elements, receiving and rejecting currents of material, while they maintain during a finite life-time their individuality, and these united into larger individuals subject to the same law. In the evolution of vegetation, which everywhere exhibits definite individuals, or organs, structurally united in indefinite series, the highest groups are composed of compound individuals in whose structure the most complex, and in every way highest evolution occurs in connection with the highest vegetable function, the perpetuity of the series of finite individuals; and, the flower once perfected, evolution has ceased, though variation continues. In the animal kingdom, as has been long appreciated, even from the ovum the part devoted to vegetal function has its surface turned inwards, and the complexity of the animal sphere, which is wrapped around the vegetal, takes place in connection with the conscious faculties. By the ministry of sensation and voluntary movement the food is introduced into the specially vegetal parts, while in connection with the perfecting of those animal functions a process takes place such as in the vegetable kingdom is seen only in the flower, namely, that the portions, whether segments or organs, become more definite in number, more fused and compact. Thus, the largest feature in the evolution of both plants and animals consists in that which is simple passing into the manifold, and the manifold being compacted together in a higher unity. These evolutions are subjected in the vegetable kingdom to the service of nutrition and reproduction; while in the animal kingdom nutrition and reproduction give way in importance to the development of intelligence. And, however imperfectly zoologists may yet agree as to the evolutions in detail in different parts of the animal kingdom, it is plain that in the human form an organism has at last appeared constituting an abode of intelligence such as exists in no other, and that in man alone intelligence reaches the capability of ascending beyond the wants of the physical organism in the contemplation of abstract truth.

This organism, I repeat, has not improved with the progress of discovery in modern science, but was at least as complete in the heroes of antiquity as in those of recent times. It is surely, then, an assumption to suppose that evolution as distinguished from variation in animal forms must go on unchecked till astronomic change shall have ended the capability of this world to support life. It is far more probable that the evolutions of the future are to be sought in realms with which the zoologist acknowledges that he has nothing to do, and take origin out of the special psychical characters of man.

For my own part I maintain that the universe, the "πρὸς τὸν Θεὸν," presents an endless unrolling of definite evolutions, and that the evolutions of organization are completed, though its variations continue, while other evolutions are at work, and more will appear.

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